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(54) **AGRICULTURAL ACCESS SYSTEMS AND METHODS**

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(51) **Int. Cl.**

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A01C 23/00	(2006.01)
F16M 11/18	(2006.01)
F16M 11/42	(2006.01)
A01M 7/00	(2006.01)
A01C 23/04	(2006.01)

(52) **U.S. Cl.**

CPC ***A01C 23/00*** (2013.01); ***A01M 7/00*** (2013.01); ***F16M 11/18*** (2013.01); ***F16M 11/425*** (2013.01); *A01C 23/04* (2013.01)

(58) **Field of Classification Search**

CPC F16M 13/022; A01C 23/00; A01C 23/003; A01C 23/005; A01G 25/00

USPC 248/550

See application file for complete search history.

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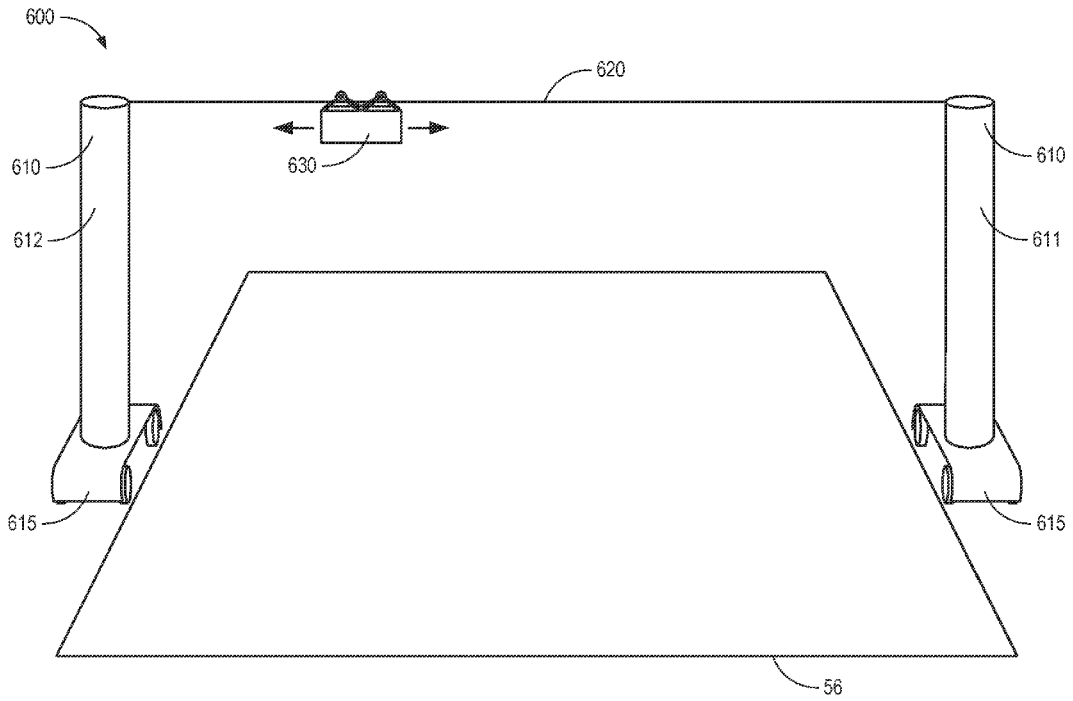
Primary Examiner — Mark Wendell

(57) **ABSTRACT**

An agricultural access system is described. The system may utilize a plurality of supports, including posts, cables, beams, and so forth to displace an access component. Control systems, sensors, delivery mechanisms, and other functions may be integrated with the system or access components. Some embodiments may include multiple cells with access components configured to interact with adjacent access components. Methods of accessing an agricultural area are also disclosed.

30 Claims, 11 Drawing Sheets



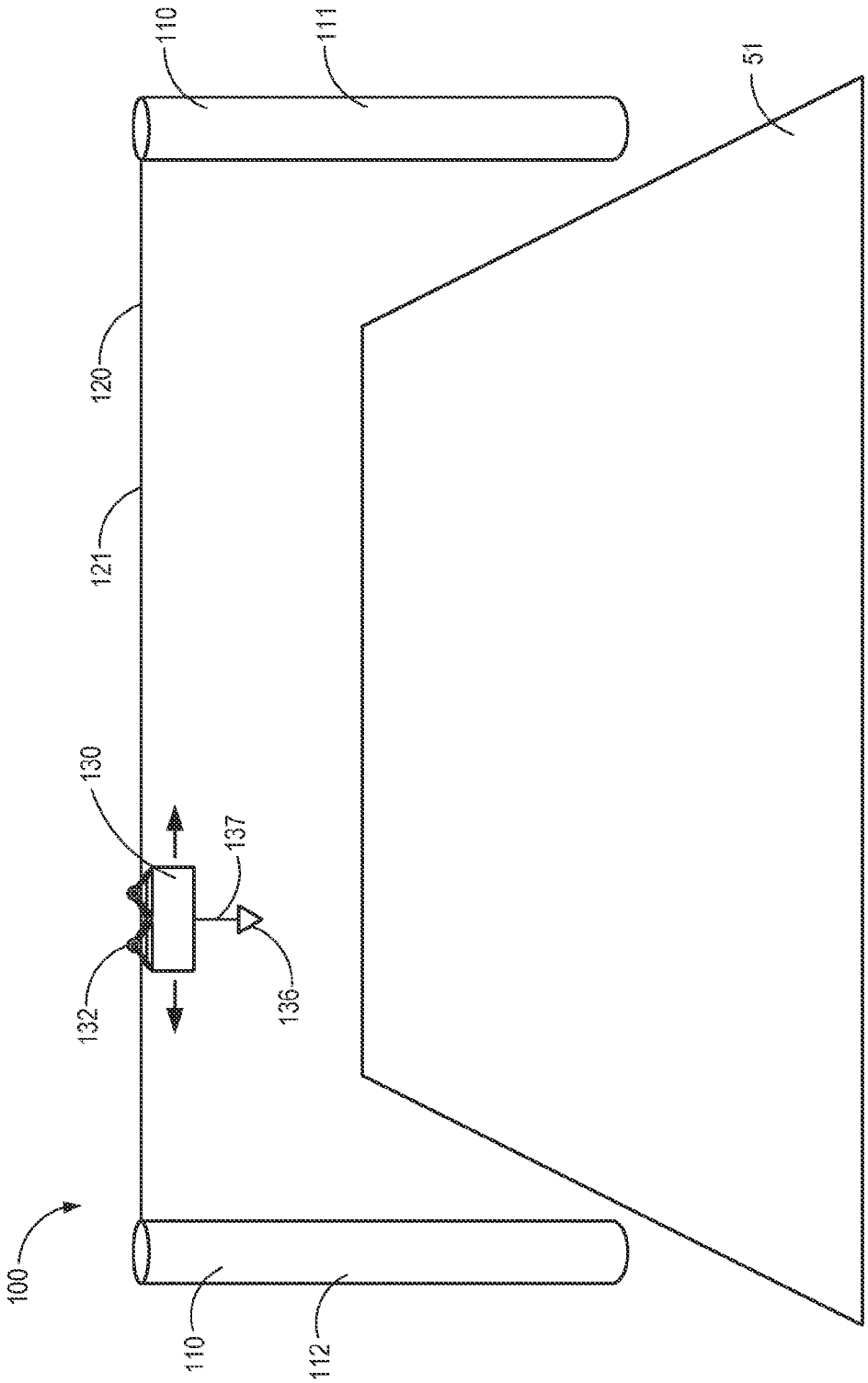


FIG. 1

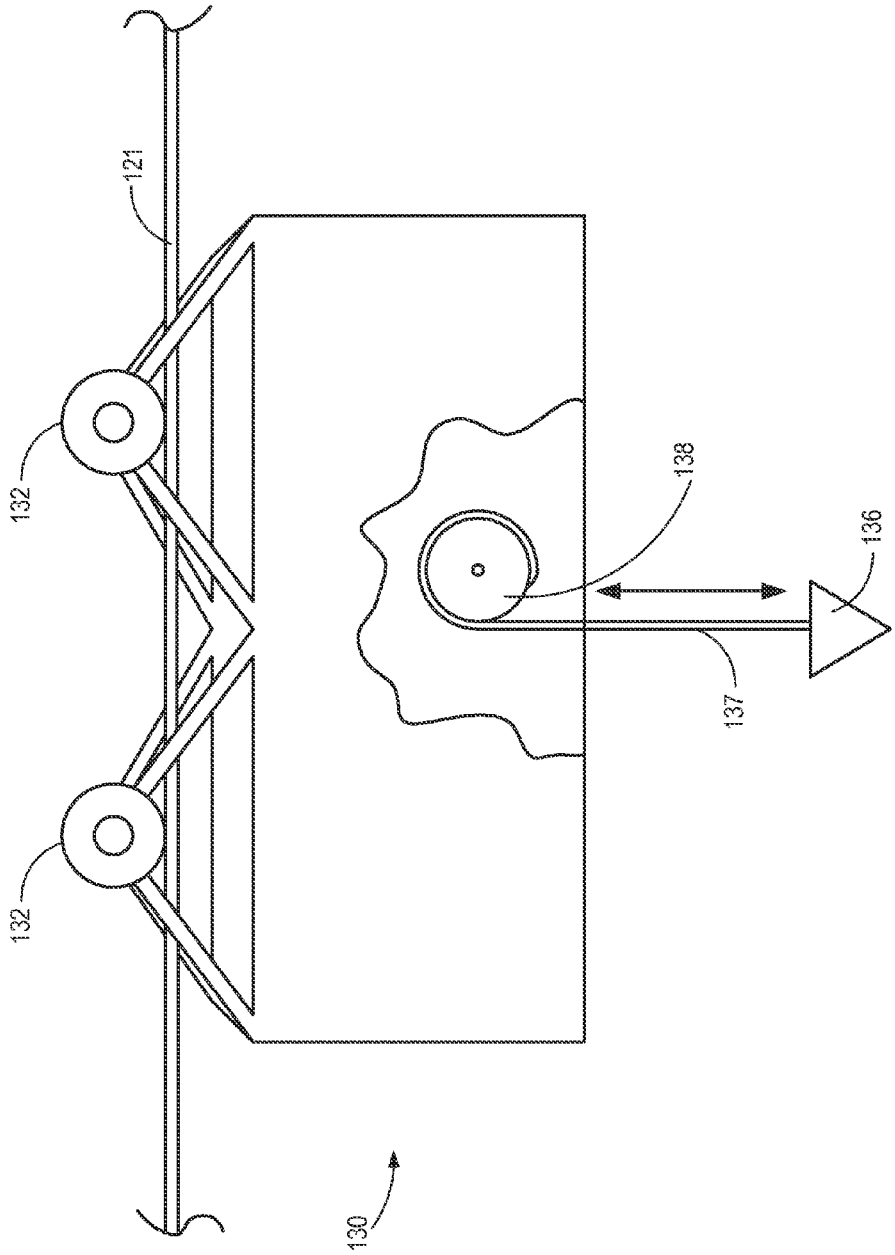


FIG. 2

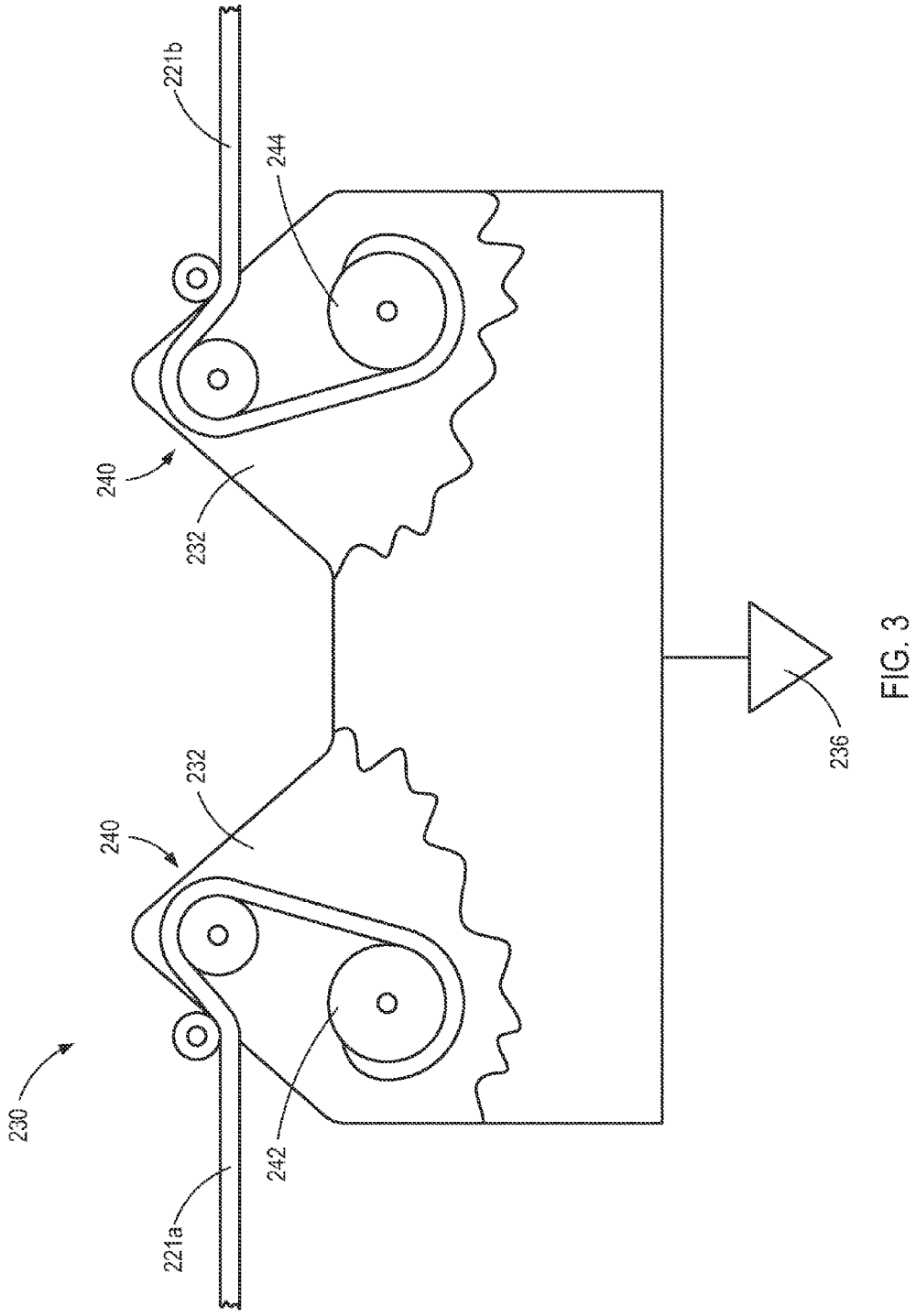


FIG. 3

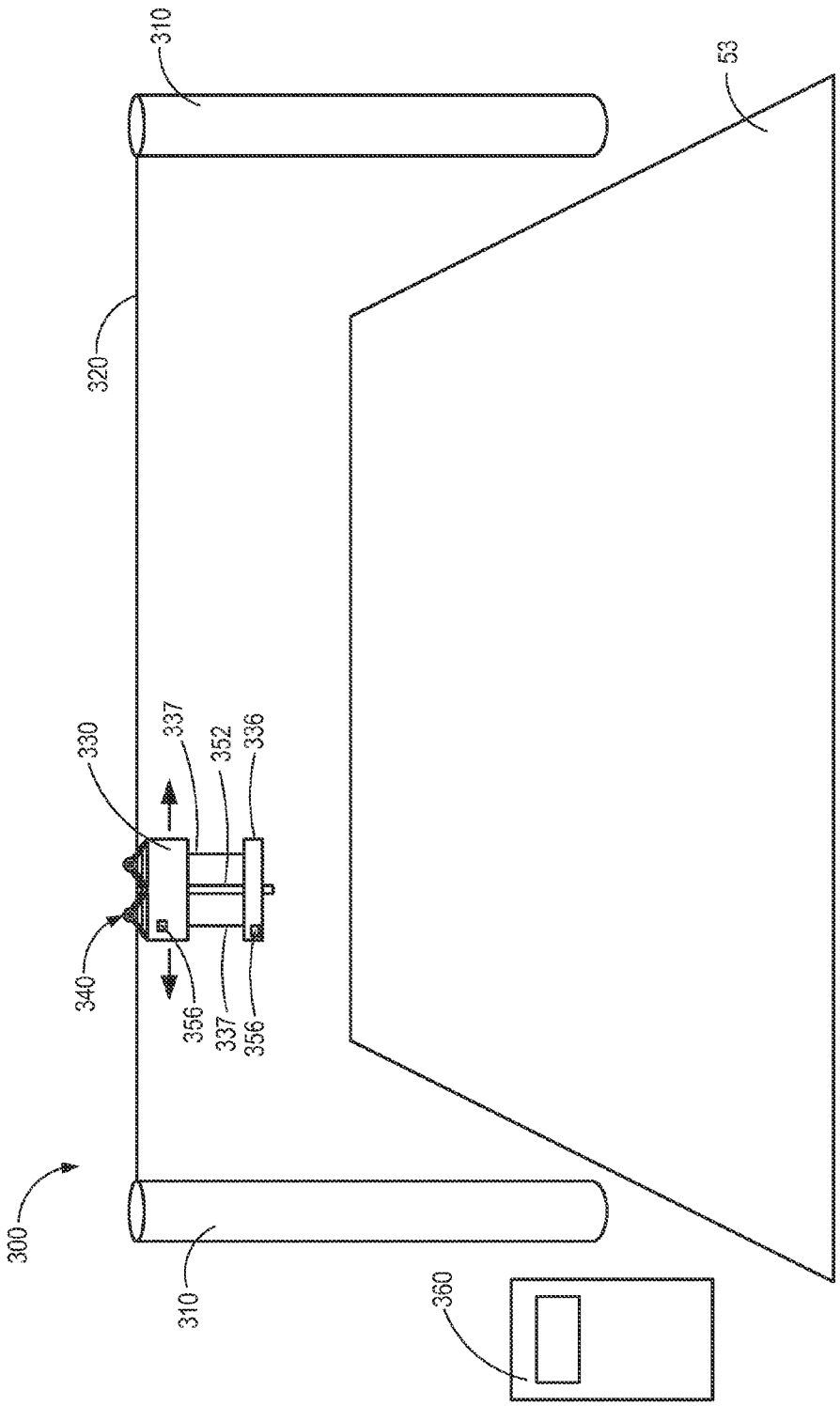


FIG. 4

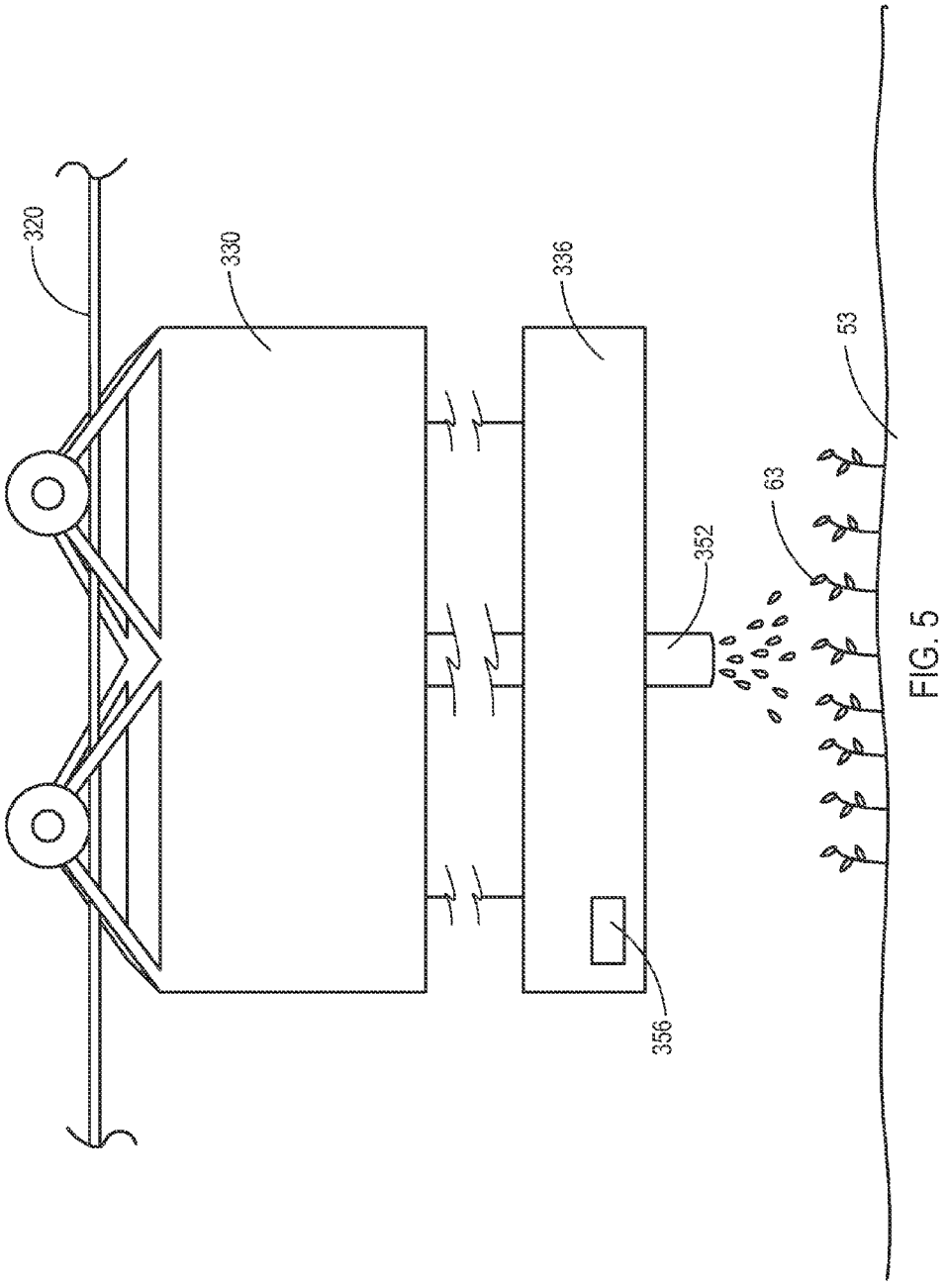


FIG. 5

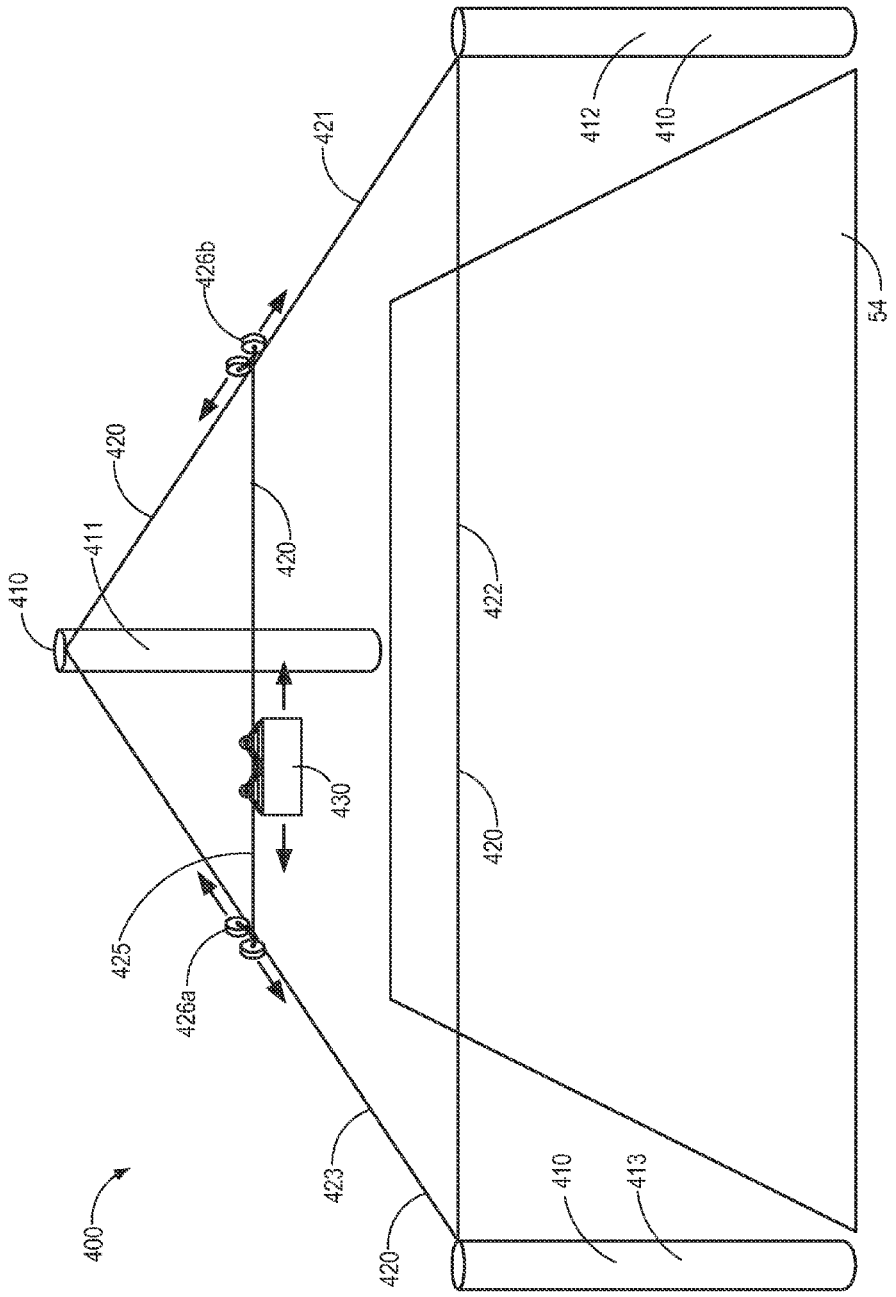


FIG. 6A

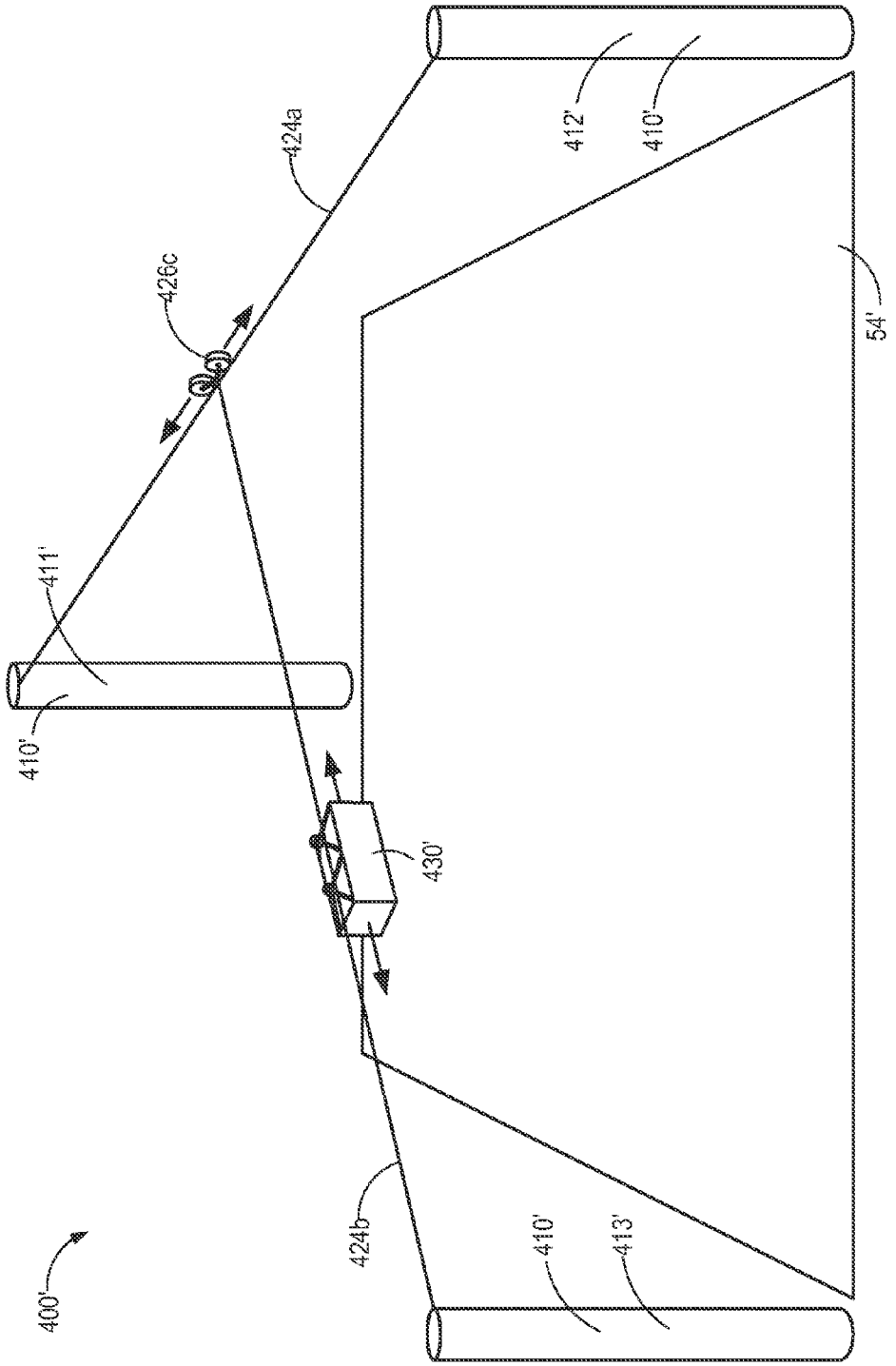


FIG. 6B

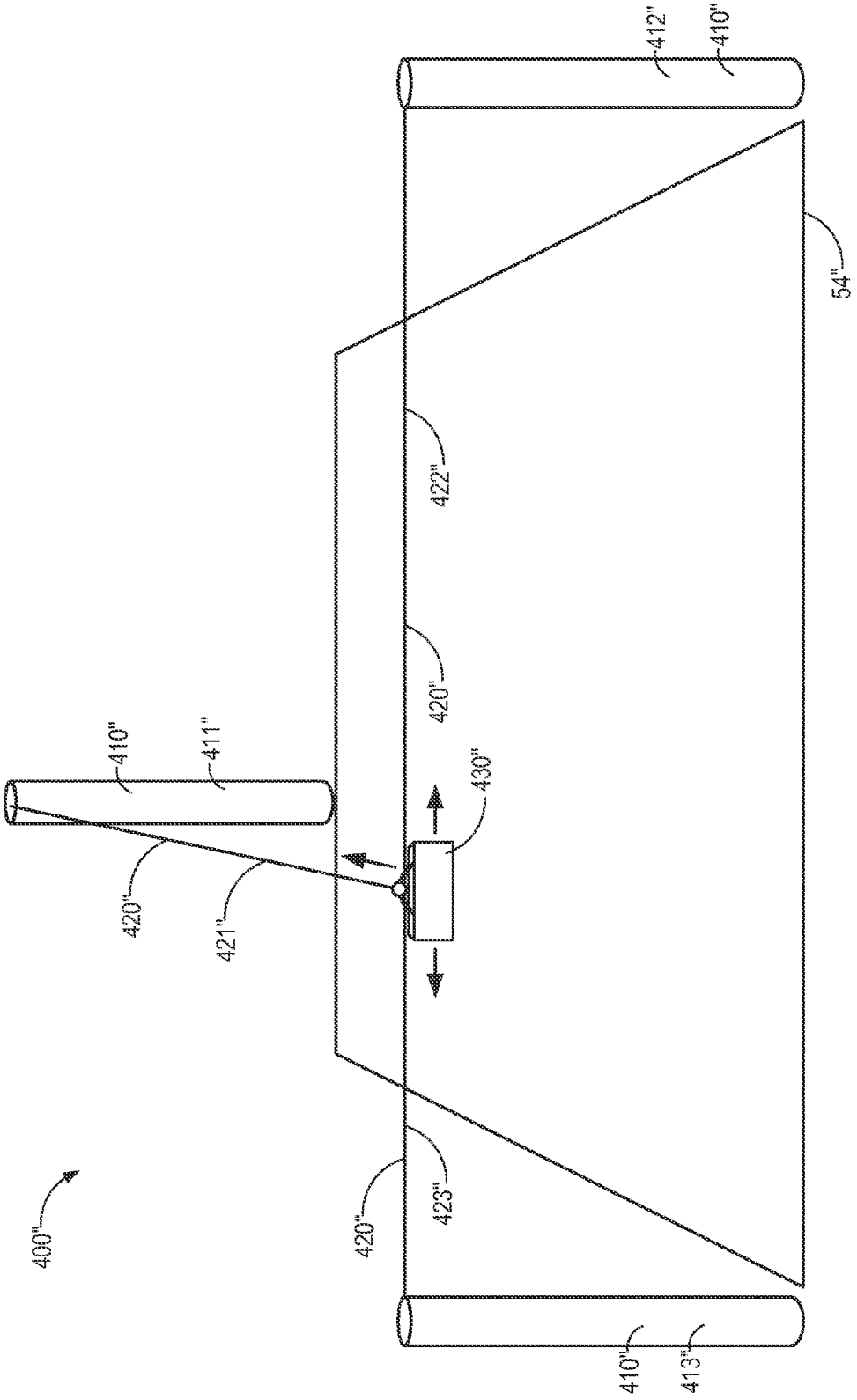


FIG. 6C

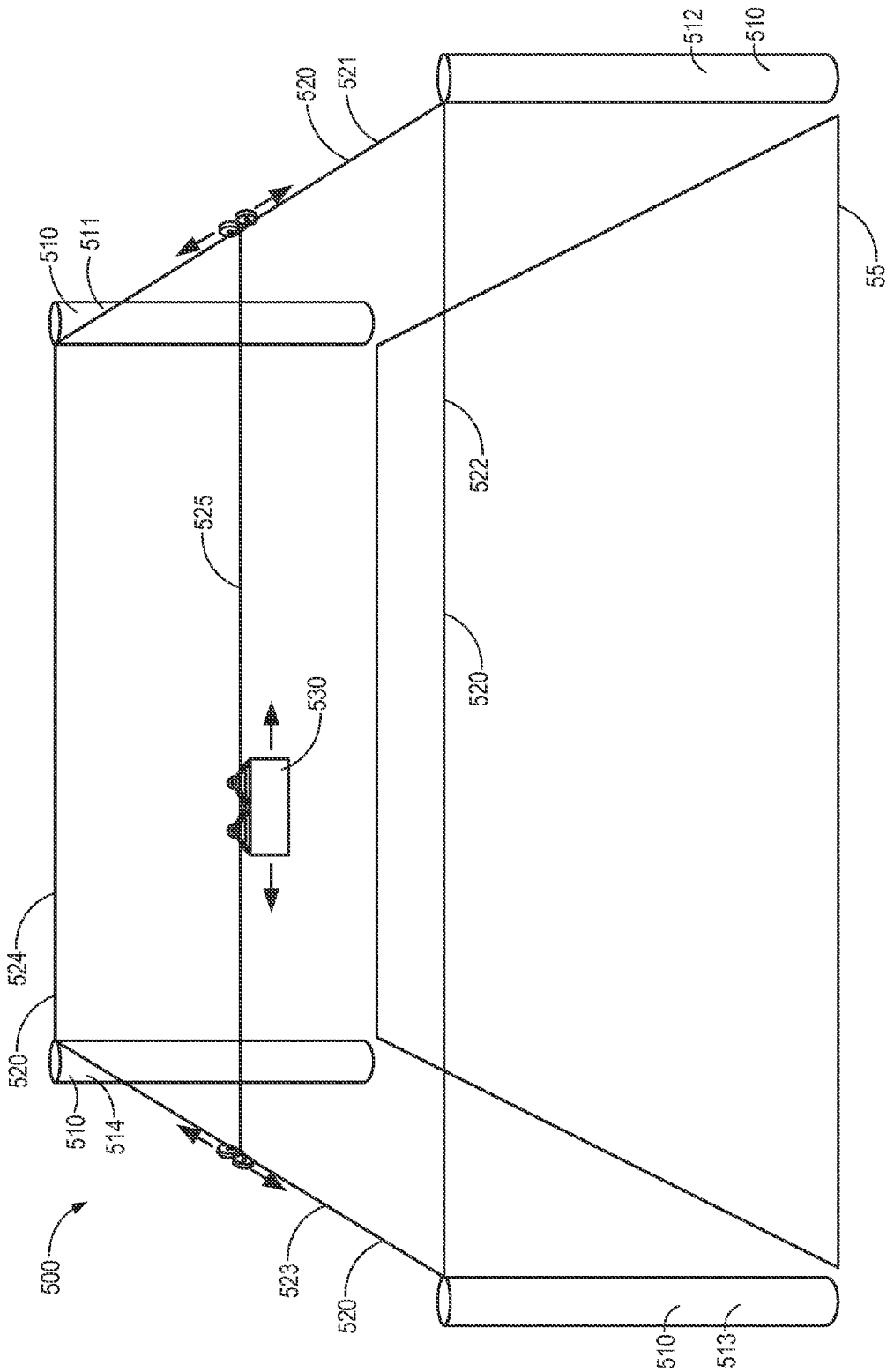

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FIG. 7

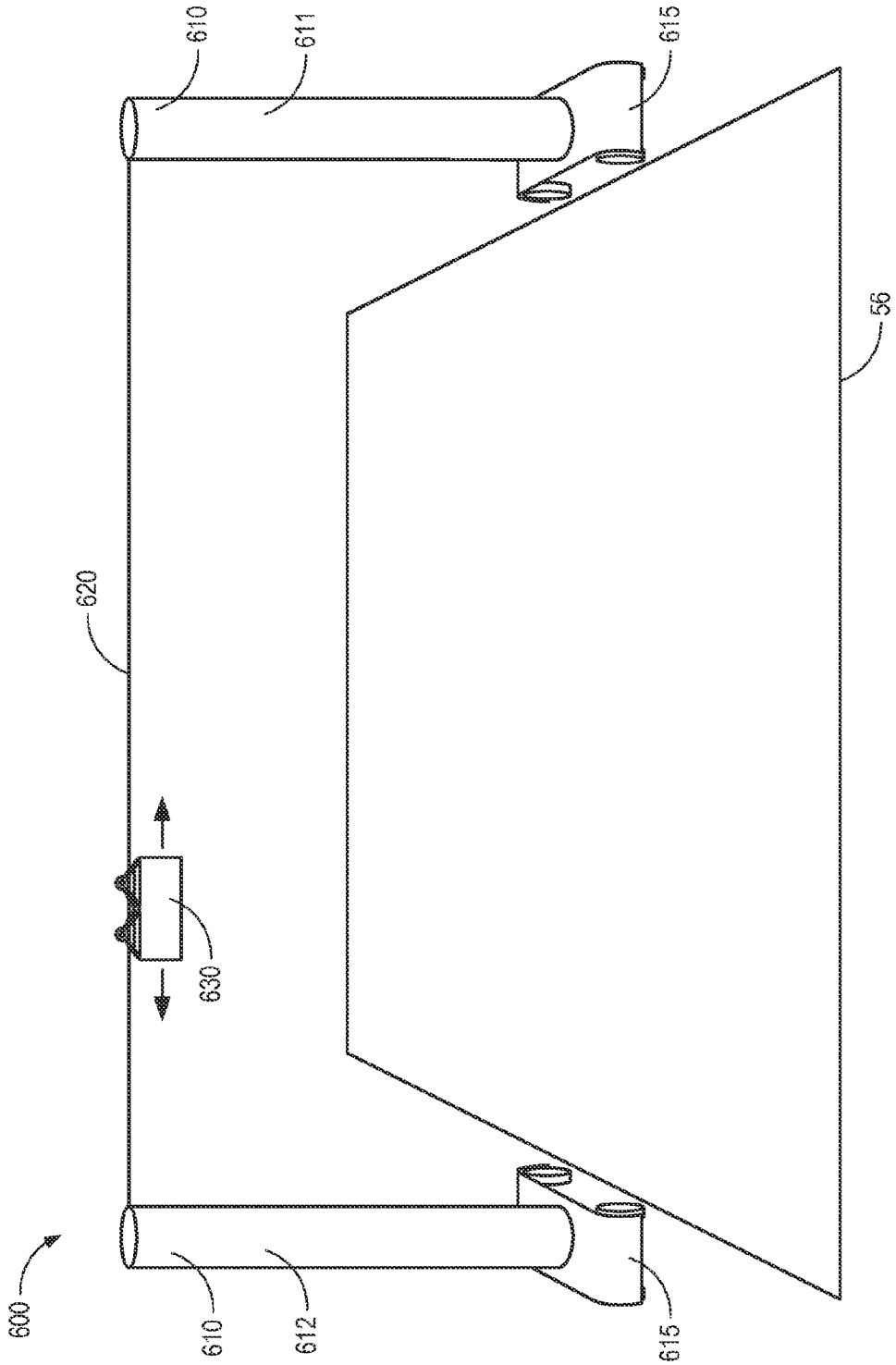

FIG. 8

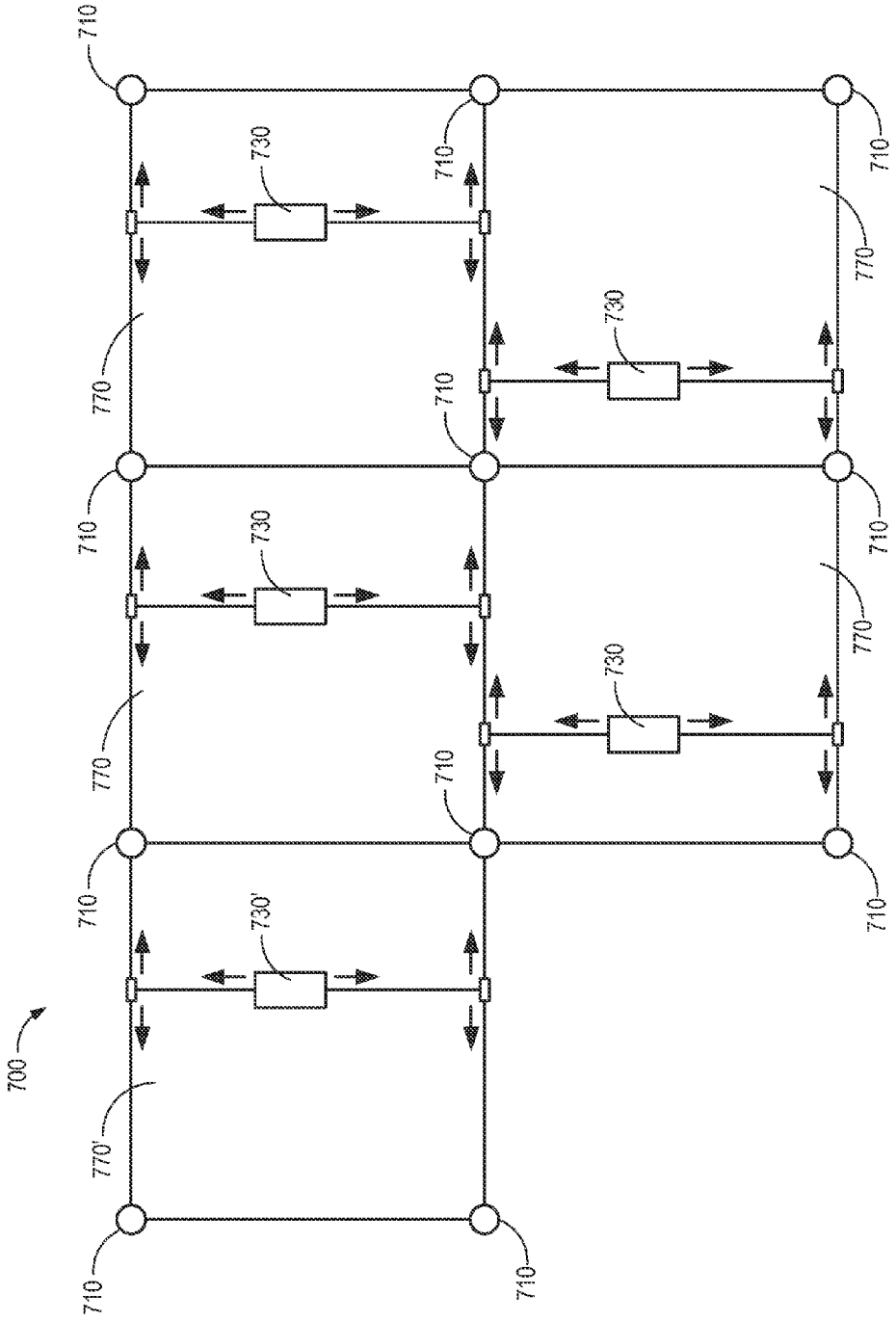

FIG. 9

AGRICULTURAL ACCESS SYSTEMS AND METHODS

If an Application Data Sheet (ADS) has been filed on the filing date of this application, it is incorporated by reference herein. Any applications claimed on the ADS for priority under 35 U.S.C. §§119, 120, 121, or 365(c), and any and all parent, grandparent, great-grandparent, etc. applications of such applications, are also incorporated by reference, including any priority claims made in those applications and any material incorporated by reference, to the extent such subject matter is not inconsistent herewith.

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application claims the benefit of the earliest available effective filing date(s) from the following listed application(s) (the "Priority Applications"), if any, listed below (e.g., claims earliest available priority dates for other than provisional patent applications or claims benefits under 35 USC §119(e) for provisional patent applications, for any and all parent, grandparent, great-grandparent, etc. applications of the Priority Application(s)). In addition, the present application is related to the "Related Applications," if any, listed below.

PRIORITY APPLICATIONS

None

RELATED APPLICATIONS

U.S. patent application Ser. No. 14/061,574, entitled AGRICULTURAL ACCESS SYSTEMS AND METHODS, naming William David Duncan, Roderick A. Hyde, and Lowell L. Wood, Jr. as inventors, filed Oct. 23, 2013, is related to the present application.

The United States Patent Office (USPTO) has published a notice to the effect that the USPTO's computer programs require that patent applicants reference both a serial number and indicate whether an application is a continuation, continuation-in-part, or divisional of a parent application. Stephen G. Kunin, Benefit of Prior-Filed Application, USPTO Official Gazette Mar. 18, 2003. The USPTO further has provided forms for the Application Data Sheet which allow automatic loading of bibliographic data but which require identification of each application as a continuation, continuation-in-part, or divisional of a parent application. The present Applicant Entity (hereinafter "Applicant") has provided above a specific reference to the application(s) from which priority is being claimed as recited by statute. Applicant understands that the statute is unambiguous in its specific reference language and does not require either a serial number or any characterization, such as "continuation" or "continuation-in-part," for claiming priority to U.S. patent applications. Notwithstanding the foregoing, Applicant understands that the USPTO's computer programs have certain data entry requirements, and hence Applicant has provided designation(s) of a relationship between the present application and its parent application(s) as set forth above and in any ADS filed in this application, but expressly points out that such designation(s) are not to be construed in any way as any type of commentary and/or admission as to whether or not the present application contains any new matter in addition to the matter of its parent application(s).

If the listings of applications provided above are inconsistent with the listings provided via an ADS, it is the intent of the Applicant to claim priority to each application that appears in the Priority Applications section of the ADS and to each application that appears in the Priority Applications section of this application.

All subject matter of the Priority Applications and the Related Applications and of any and all parent, grandparent, great-grandparent, etc. applications of the Priority Applications and the Related Applications, including any priority claims, is incorporated herein by reference to the extent such subject matter is not inconsistent herewith.

TECHNICAL FIELD

The present disclosure relates generally to agricultural access systems. Agricultural access systems may be configured to deliver materials and/or otherwise interact with portions of an agricultural field. The systems may be remotely controlled and may be configured to access the field from above.

BRIEF DESCRIPTION OF THE DRAWINGS

The embodiments disclosed herein will become more fully apparent from the following description and appended claims, taken in conjunction with the accompanying drawings. The drawings depict exemplary embodiments of the present disclosure. Various features of these embodiments will be described with additional specificity and detail through reference to the drawings, in which:

FIG. **1** is a schematic view of an embodiment of an agricultural access system having two vertical support members.

FIG. **2** is a schematic view of an access component of the agricultural access system of FIG. **1**.

FIG. **3** is a schematic view of another embodiment of an access component.

FIG. **4** is a schematic view of another embodiment of an agricultural access system having two vertical support members and a control system.

FIG. **5** is a schematic view of an access component of the agricultural access system of FIG. **4**.

FIG. **6**A is a schematic view of another embodiment of an agricultural access system having three vertical support members.

FIG. **6**B is a schematic view of another embodiment of an agricultural access system having three vertical support members.

FIG. **6**C is a schematic view of another embodiment of an agricultural access system having three vertical support members.

FIG. **7** is a schematic view of another embodiment of an agricultural access system having four vertical support members.

FIG. **8** is a schematic view of another embodiment of an agricultural access system having two movable vertical support members.

FIG. **9** is a top schematic view of another embodiment of an agricultural access system having a plurality of cells and access components.

DETAILED DESCRIPTION

Agricultural access systems may be configured to access various portions of an agricultural field while minimizing interaction of the system with the field. For example, an access system may be configured to access the field from

above, limiting contact between the system and the field. Vertical support components may be positioned around the perimeter of the field, facilitating control over which portions of the field are contacted by the access system.

An agricultural access system may further be configured for remote control or may be controlled by an automated or partially automated control system. The system may be configured to facilitate certain interactions with the field (delivery of materials such as pesticides) while limiting unwanted disturbance of the field. Further, the access system may be configured to access certain portions of the field, delivering materials only to specific targets within the field.

An agricultural access system configured for overhead access may utilize cable systems, pulleys, winches, booms, and so forth to facilitate access while limiting interaction with the field or limiting contact with specific areas of the field. Such systems may be configured to deliver materials or otherwise interact with the agricultural field based on input from sensors configured to monitor conditions within the field.

An access system may be configured with movable support posts in some instances. Further, certain access systems may comprise multiple cooperating components, such as multiple access components disposed in adjacent cells or portions.

It will be readily understood that the components of the embodiments as generally described and illustrated in the Figures herein could be arranged and designed in a wide variety of different configurations. Thus, the following more detailed description of various embodiments, as represented in the Figures, is not intended to limit the scope of the disclosure, but is merely representative of various embodiments. While the various aspects of the embodiments are presented in drawings, the drawings are not necessarily drawn to scale unless specifically indicated.

The phrases "connected to," "coupled to," and "in communication with" refer to any form of interaction between two or more entities, including mechanical, electrical, magnetic, electromagnetic, fluid, and thermal interaction. Two components may be coupled to each other even though they are not in direct contact with each other. For example, two components may be coupled to each other through an intermediate component.

FIG. **1** is a schematic view of an embodiment of an agricultural access system **100** having two vertical support members **111**, **112**. The illustrated embodiment further comprises an elevated lateral support member **121**. In the illustrated embodiment, the vertical support members are collectively designated with the reference numeral **110**, while specific vertical support members are designated as consecutive numerals following the general reference numeral. Thus, reference numeral **110** designates the plurality of vertical support members, or the vertical support members generally, while the first vertical support and second vertical support of the illustrated embodiment are each designated by the specific reference numerals **111** and **112**, respectively. Likewise, the reference numeral **120** designates elevated lateral support members within the illustration, while the first elevated lateral support is specifically designated **121** in the illustrated embodiment. (Note: In the embodiment of FIG. **1**, there is only one elevated lateral support, **121**.) This pattern continues throughout this disclosure, though subsequent embodiments differ from the present embodiment by incrementing the first digit of the reference numeral by 1.

In the embodiment of FIG. **1**, the first vertical support member **111** and second vertical support member **112** are fixed to the ground around the perimeter of an agricultural field **51**. In other embodiments, one or both of the vertical support members may be located within the agricultural field. The elevated lateral support **121** extends between the first **111** and second **112** vertical support members. An access component **130** is disposed on the elevated lateral support **121**.

As indicated by the arrows in the illustrated embodiment, the access component **130** may be displaceable along the elevated lateral support member **121**. Thus, the access component may be configured to access various portions of the agricultural field **51** between the first **111** and second **112** vertical support members.

The vertical support members **110** may comprise vertical posts or other components configured to support the elevated lateral support member **121** above the field **51**. In some embodiments, one or more of the vertical support members **110** may comprise a naturally occurring feature such as a tree, boulder, or hill. The vertical support members **110** may be fixed to the ground by burying posts or setting them in concrete, or may be fixed to the ground in the sense that they rest upon the ground and are not configured to readily move (for example the vertical support members **110** may comprise collapsible tripods). In another embodiment, agricultural field **51** may have a plurality of pre-emplaced support pads located around its perimeter, each of which provides an anchor point for vertical support members **110**; in operation, vertical support members **110** may be attached to a desired subset of the support pads, thereby allowing coupled access components to access various portions of the agricultural field **51**. Thus, the system **100** may be permanently installed or configured to be set up for use, then removed or reconfigured following use.

The elevated lateral support member **121** may extend between the vertical support members **110**. The elevated lateral support member **121** may comprise a cable extending between vertical support members **110** or may comprise a rigid member such as a beam. In some instances, a rigid elevated lateral support member may be coupled to only one vertical support member. In such embodiments, the elevated lateral support member may be configured to pivot with respect to the coupled vertical support member, allowing the elevated lateral support member to operate as a boom.

The elevated lateral support member **121** may be fixed at one or both ends with respect to the vertical support members **110** or may be displaceable at one or both ends. For example, in some embodiments the elevated lateral support member **121** may be configured to move vertically along the vertical support members **110**. In such embodiments, the vertical distance between the elevated lateral support member **121** and the field **51** may be adjusted or controlled based on the position of the elevated lateral support member **121** on the vertical support members **110**.

The access component **130** may again be displaceable along the elevated lateral support member **121**. Varying the position of the access component **130** along the elevated vertical support member **121** as well as varying the position of the elevated lateral support member **121** with respect to the vertical support members **110** may thus allow the access component **130** to be positioned at any vertical or horizontal position between the vertical support members **110**. In other words, the access component **130** may be displaceable to any point in a plane extending between the vertical support members **110**.

The access component **130** may further comprise a coupling portion **132** configured to couple the access component **130** to the elevated lateral support member **121** and an extension portion **136** configured to extend from the coupling portion **132**. The extension portion **136** may be displaceable with respect to the coupling portion **132**. For example, the extension portion **136** may be configured to extend between

the coupling portion **132** and the field **51**. In some embodiments, the elevated lateral support member **121** may be fixed with respect to the vertical support members **110** and vertical displacement of the access component **130** may be solely tied to displacement of the extension portion **136** of the access component **130**. In other embodiments, a combination of vertical displacement of the elevated lateral support member **121** and the extension portion **136** may be configured to control the position of the access component **130**.

The extension portion **136** of access component **130** may be coupled to the coupling portion **132** by a vertical access member **137**. The vertical access member **137** may be rigid or flexible and may be configured to extend vertically above and/or vertically below the coupling portion **132**. The vertical access member **137** may comprise both flexible and rigid segments disposed adjacent each other, such as in series. The vertical access member **137** may be configured to extend at an angle with respect to the coupling portion **132**. In some embodiments, the vertical access member **137** may comprise a generally flexible member and the extension portion **136** may be displaced by gravity as the vertical access member **137** is lengthened or shortened.

The access component **130** may be configured to monitor conditions on the field **51** (for example through sensors mounted on the access component **130**) or may be configured to directly interact with the field **51** in a variety of ways (for example, delivering pesticides to particular portions of the field **51**).

As used herein, the field of motion of the access component **130** refers to the space in which the access component **130** may be positioned by the system **100**, including space accessible by any portion of the access component **130**, such as the extension portion **136**. Thus, in an embodiment wherein the access component **130** was displaceable along the elevated lateral support **121**, but neither the access component **130** nor elevated lateral support **121** was vertically displaceable, the field of motion would extend along a substantially linear path in the direction of the elevated lateral support member **121**. In the illustrated embodiment of FIG. **1**, the field of motion of the access component **130** may comprise a plane extending between the vertical support members **110**, as the extension portion **136** of the access component **130** is vertically displaceable from the linear path of the elevated lateral support member **121**. In embodiments wherein the access component is also displaceable in a direction out of the plane (for example embodiments with additional vertical support members), the field of motion may comprise a three-dimensional space, bordered or defined by various components of the system **100**.

As used herein, the field of regard of the access component **130** refers to an area or space wherein the access component **130** can sense conditions or otherwise interact with the space. Thus, the field of regard of the access component **130** may be more extensive than the field of motion of the access component **130**. For example, the access component **130** may be configured to sense conditions, or deliver materials (such as through spraying), to areas outside its field of motion. The field of motion and the field of regard may each comprise a three-dimensional space in some embodiments.

FIG. **2** is a more detailed schematic view of the access component **130** of the agricultural access system **100** of FIG. **1**. In the view of FIG. **2**, the access component **130** is shown along with the coupling portion **132** and extension portion **136** of the access component **130**. A portion of the elevated lateral support member **121** is also shown.

Further, as shown in the cutaway portion, the access component **130** of the illustrated embodiment further comprises a winch **138** operatively coupled to the vertical access member **137**. In the illustrated embodiment the vertical access member **137** comprises a flexible cable which is operatively coupled to the winch **138**. Rotational displacement of the winch **138**, together with the force of gravity acting on the extension portion **136**, may thus control the vertical position of the extension portion **136** with respect to the coupling portion **132**.

The access component **130** may be displaceable along the elevated lateral support member **121**. In some instances, horizontal displacement of the access component **130**, or displacement above the ground in a plane orthogonal to the vertical direction, may be related to translation of the access component **130** in the direction of the elevated lateral support member **121**. Further, in some embodiments, the elevated lateral support member **121** may comprise a continuous cable and the access component **130** may be configured to move along the continuous cable. A propulsion system may be configured to displace the access component **130** along the elevated lateral support member **121**. In some instances, for example, the coupling portion **132** may comprise one or more motors configured to move the access component **130** along the elevated vertical support member **121**. Embodiments comprising gears, sprockets, chains, and so forth are likewise within the scope of this disclosure. In other embodiments, the coupling portion **132** may comprise pulleys or wheels configured to freely move along the elevated vertical support member **121**. In such embodiments, the force to displace the access component **130** may be supplied by additional components (such as one or more tension cables coupled to the access component). Still further, the access component **130** may be fixed to the elevated lateral support member **121** and lateral displacement of the elevated lateral support member **121** may be configured to displace the access component **130**.

FIG. **3** is a schematic view of another embodiment of an access component **230**. The access component **230** of FIG. **3** may be used with any of the agricultural access systems disclosed herein. Further, the embodiment of FIG. **3** may include components that resemble components of the embodiment of FIGS. **1** and **2** in some respects. For example, the embodiment of FIG. **3** includes an access component **230** that may resemble the access component **130** of FIGS. **1** and **2**. It will be appreciated that all the illustrated embodiments have analogous features and components. Accordingly, like or analogous features are designated with like reference numerals, with the leading digits incremented to "2." Relevant disclosure set forth above regarding similarly identified features thus may not be repeated hereafter. Moreover, specific features of the access member **230** and related components shown in FIG. **3** may not be shown or identified by a reference numeral in the drawings or specifically discussed in the written description that follows. However, such features may clearly be the same, or substantially the same, as features depicted in other embodiments and/or described with respect to such embodiments. Accordingly, the relevant descriptions of such features apply equally to the features of the system and related components of FIG. **3**. Any suitable combination of the features, and variations of the same, described with respect to the access component **130** illustrated in FIGS. **1** and **2** can be employed with the system and components of FIG. **3**, and vice versa. This pattern of disclosure applies equally to further embodiments depicted in subsequent figures and described hereafter. Further, this pattern of disclosure applies generally to the various systems and related components disclosed herein, not just access components specifically. Thus, disclosure relative to any embodiment may be analogously applied to any other embodiment herein.

The agricultural access component **230** of FIG. **3** comprises a coupling portion **232** and an extension portion **236**. As further detailed below, the access component **230** may comprise a propulsion system **240** configured to displace the access component **230** through cooperative interaction with portions of an elevated lateral support member **221***a*, **221***b*. In the embodiment of FIG. **3**, the coupling portion **232** is coupled to the elevated lateral support member **221***a*, **221***b*. In the illustrated embodiment, the elevated lateral support member comprises two segments, a first segment **221***a* and a second segment **221***b*. In the illustrated embodiment, the first **221***a* and second **221***b* segments are not directly coupled to each other. Further, in the illustrated embodiment the first segment **221***a* of the elevated lateral support is coupled to a first reel **242** and the second segment **221***b* of the elevated lateral support is coupled to a second reel **244**. Each of the first **221***a* and second **221***b* segments may also be coupled to another component, such as first and second vertical support members (not shown).

In embodiments wherein the first **221***a* and second **221***b* segments are fixed to another component (such as a vertical support member) rotational displacement of the first **242** and second **244** reels may be configured to displace the access component **230**. For example, the first **242** and second **244** reels may cooperate such that the first reel **242** rotates to add slack to the first segment **221***a* of the elevated lateral support member while the second reel **244** rotates to take up slack on the second segment **221***b* of the elevated lateral support member. The reels **242**, **244** may cooperate such that the entire elevated lateral support member **221***a*, **221***b* remains taut during this rotation and the access component is displaced in the direction in which the second segment **221***b* of the elevated lateral support extends from the access component **230**.

In other embodiments, the first **221***a* and second **221***b* segments of the elevated lateral support may be fixed at the access component **230** and be coupled to reels at other locations, such as at the vertical support members or at the ground. For example, the first **221***a* or second **221***b* segment of the elevated lateral support may be fixed at the access component **230**, run over a pulley on a vertical support member, and coupled to a reel, including a motorized reel, disposed on the ground. Any number of reels and/or pulleys may be used to alter the length of the segment extending from the access component **230** by taking up a portion of the segment on a reel. Again, cooperative adjustments to such segments may be configured to displace the access component **230** along the directions of the segments extending from the access component **230**. Further, intermediate components may be disposed between the first **221***a* and second **221***b* segments of the elevated lateral support member and the access component **230**, any vertical support members, the ground, or any other coupling location.

FIG. **4** is a schematic view of another embodiment of an agricultural access system **300** having two vertical support members **310** and a control system **360**. The control system **360** may comprise a processor or another signal processing element. The control system **360** may be disposed adjacent the agricultural field **53** where the system **300** is deployed or may be disposed at a remote location. Further, the control system **360** may be positioned on or within any component of the agricultural access system **300**, including embodiments wherein the control system **360** is disposed on board the agricultural access component **330**.

The control system **360** may be configured to control the position of the access component **330** within the field of motion of the access component **330**. For example, the control system **360** may interact with a propulsion system **340** configured to displace the access component **330** along the elevated lateral support **320**. The control system **360** may also control the position of the extension portion **336** of the access component **330** by adjusting the vertical access member **337**. Regardless of the mechanics by which the access component **330** is displaced (e.g., vertical displacement of the elevated lateral support member **320** along the vertical support members **310**, manipulation of segments of the elevated lateral support member **320** extending from the access component, etc.) the control system **360** may be configured to control displacement of the access component **330**. Any method of displacement disclosed herein may be used in connection to any control system **360** disclosed herein. Further, the control system **360** may be configured to simultaneously control various components of the system **300** to quickly and smoothly displace the access component **330** to any position within the field of motion of the access component **330**.

The control system **360** may be programmed to control the position of the access component **330** according to a sequence of positions of the access component **330**. For example, the control system **360** could be programmed to serially dispose the access component **330** over various sectors of the field **53**, for example to deliver pesticides or other agents to those sectors. The control system **360** may further be configured to control the time at which the access component **330** is disposed at particular positions, for example by positioning the access component **330** at a predetermined location at the same time each day. Still further, the control system **360** may be configured to control the duration of time at which the access component **330** is disposed at a particular location or at various positions in a sequence of locations.

The access system **300** may further comprise one or more sensors **356**. In the illustrated embodiment, sensors **356** are shown on the extension portion **336** of the access component **330** as well as on other locations on the access component **330**. In other embodiments sensors **356** may be positioned on, or mechanically coupled to, any other component of the system **300**, including, for example, vertical support members **310**, elevated lateral support members **320**, and so forth. Additionally or alternatively, sensors **356** may be disposed in other locations in or around the field **53**, including on the ground, even if not abutting another component of the system **300**.

The sensors **356** may be configured to provide input directly to the control system **360** or may be configured to provide data to a user who may then alter the control system **360**. In some instances the control system **360** may be configured to automatically respond to sensor input. The sensors **356** may be connected to the control system **360**, other sensors **356**, or any user readout system through electrical connections, communications cables, wireless connections, and so forth. Thus the sensors **356** may be in communication with a transmitter configured to deliver data to an external component, including wireless transmitters. In some embodiments, the sensors **356** and related systems may be separate from the control system **360**.

The sensors **356** may be configured to detect various conditions or features on the system itself **300** or conditions within the field of regard of the system **300**. Again the field of regard may be coextensive with, or larger than, the field of motion of the access component **330** of the system **300**. For example, the sensors **356** may be configured to monitor an area which is not identical to the field of motion of the access component. Various sensors **356** are within the scope of this disclosure. Exemplary sensor embodiments include, but are not limited to, cameras, spectrometers, moisture sensors, soil

sensors, radar, lidar, and so forth. In some embodiments the access component **330** or other components may comprise an illumination component which may be used in connection with various sensors (e.g., cameras). The illumination component may provide spectral illumination, polarized illumination, pulsed illumination, nighttime illumination, focused illumination, directional illumination, or the like.

The control system **360** may be configured to communicate with components of the system **300** through electrical connections, communications cables (e.g., optical fibers, coaxial cable, etc.), wireless connections and so forth. For example, the control system **360** may communicate between a remote processing unit and a propulsion system or sensor on board the access component through a wireless connection.

The control system **360** may be configured to displace the access component **330** to automatically avoid obstacles within the field of motion of the access component **330**. For example, the control system **360** could be programmed to avoid locations within the field of motion which contain particular features, such as avoiding certain plants or features when delivering a potentially harmful herbicide to other locations within the field of motion. The control system **360** may be configured to automatically detect and avoid obstacles such as rocks or trees within the field of motion. The control system **360** may further be configured to avoid collision between the access component **330** and moving obstacles, such as animals, people, or vehicles, within the field of motion.

In addition to other sensors described above, a GPS receiver may be incorporated into one or more components of the system **300** and may be used in connection with guidance of the access component **330** within the field of motion. Additionally, the access component **330** may comprise a receiver configured to receive various control and positioning instructions from the control system **360** or other inputs. The receiver may comprise a wireless receiver and/or may be coupled via a communications control cable.

The access component **330** may comprise various location determination components. Signals from these components may be fed into the control system **360** or other outputs. Again, a GPS receiver may comprise one such location determination component. Further, location determination components on the access component **330** may be configured to interact with other components such as external position references. For example, external cameras positioned within or around the field **53** may image the location determination component on the access component **330** and triangulate the position of the access component **330**. Further, external transmitters may beam signals which are received by the location determination component to triangulate a position. Still further, the location determination component on the access component **330** may emit a signal which is processed by external receivers to determine a position. Various other location determination techniques are within the scope of this disclosure.

The control system **360** may also be configured to control various functions of the access component **330** or the system **300**. For example, the access component **330** may be configured to deliver a material to locations within the field of regard or field of motion of the access component **330**. In the illustrated embodiment, the access component **330** further comprises a conduit **352** which may be configured to deliver a material. In some embodiments, the material may be stored in a reservoir located on access component **330**. In some embodiments, the material may be stored in a distal reservoir located elsewhere in the system **300** (e.g., attached to lateral support member **320**, attached to vertical support member **310**, located on an external vehicle, located on the ground, etc.). In such embodiments, conduit **352** may extend from the reservoir to access component **330**, and may itself be coupled to lateral support member **320** or to vertical support member **310**.

FIG. **5** is a schematic view of the access component **330** of the agricultural access system **300** of FIG. **4**. In the configuration of FIG. **5**, the extension portion **336** of the access component **330** is displaced from the elevated lateral support member **320** such that the extension portion **336** is disposed adjacent the field **53**. Plants **63** within the field **53** are also shown as well as a sensor **356** on the extension portion **336**.

As illustrated in FIG. **5**, the conduit **352** may be used to deliver a material to the field. The conduit **352** may extend from other portions of the system **300** to direct the material. For example, the conduit **352** may extend to, and may be coupled to, a vertical support member (**310** of FIG. **4**) and/or a lateral support member **320** of the system. The conduit **352** may comprise flexible portions in some embodiments. Various conduits **352** configured to deliver material are within the scope of this disclosure, for example, pipes, tubes, channel, screw drives, and so forth. Conduit **352** may include a nozzle, a steerable portal, a metering system, etc.

The conduit **352** or other delivery system may be configured to deliver various materials. Exemplary materials within the scope of this disclosure include, but are not limited to, fertilizers, water, pesticides, plant hormones, herbicides, pollen, seeds, materials configured to be dispersed above the ground, materials configured to be delivered by penetrating the ground, and so forth.

The extension member **336**, or another portion of the access component **330**, may additionally or alternatively be configured to interact with the field **53** in various ways. For example, the extension member **336** may be configured to penetrate the ground. It may be configured to mechanically interact with the field **53** or plants **63** within the field **53**. It may be configured to plant seeds, harvest plants or portions of plants, mechanically remove weeds or other unwanted plants, physically damage unwanted plants, and control vermin. The access component **330** may be configured to control vermin in a variety of ways, including by frightening vermin (e.g. via noise, lights, odors), mechanically removing vermin, poisoning vermin, and by shooting projectiles at vermin. The system may be configured to automatically sense any of these conditions or situations (e.g., need for water, herbicide, weed removal, vermin control, etc.) and automatically respond.

The access component **330** may further comprise a portion, such as the extension portion **336**, configured to couple to one or more tools. One or more tools may be stored within the field of motion of the access component **330**, such that the system can access and couple such tools as needed.

The access component **330** or other portions of the system may further be configured with dampening components to limit oscillations or other unwanted movement within the system. The dampening components may be actively controlled, for example by a sensor coupled to the control system (**360** of FIG. **4**).

Referring to FIGS. **4** and **5**, the system **300** may further comprise a mobility system configured to control a transverse position of the access component **330** relative to the elevated lateral support member **320**. The mobility system may control transverse motion of the elevated lateral support member **320** or transverse motion of the access component **330**. The mobility system may further be configured to control a transverse oscillation of the vertical access member **337** coupling the extension portion **336** to the elevated lateral support member **320**.

FIG. **6** is a schematic view of another embodiment of an agricultural access system **400** having three vertical support members **410**. Specifically, the system **400** comprises a first vertical support member **411**, a second vertical support member **412**, and a third vertical support member **413**. Each of these vertical support members **410** may be fixed to the ground. Any of the vertical support members **410** may be located either within or outside of agricultural field **54**.

The system **400** further comprises three elevated lateral support members **420**, a first elevated lateral support member **421**, a second elevated lateral support member **422**, and a third elevated lateral support member **423**. The access component **430** of the system may be coupled to any or all of the elevated lateral support members **420** using any method or structure. In the illustrated embodiment, a moveable elevated lateral support member **425** is coupled to the first elevated lateral support member **421** and the third elevated lateral support member **423**. The moveable elevated lateral support member **425** may be coupled at first **426***a* and second **426***b* ends such that the ends **426***a*, **426***b* may move along the lengths of the first **421** and third **423** elevated lateral support members, respectively. The movable elevated lateral support member **425** may comprise a length support member, and the access component **430** may be displaceable along the length of the movable elevated lateral support member **425**. The ends **426***a* and **426***b* of the movable elevated lateral support member **425** may be displaceable along the length of the first **421** and third **423** elevated lateral supports or the first **421** and third **423** elevated lateral support members may comprise segments which may be adjusted analogously to the propulsion system disclosed in connection with FIG. **3**. Again, any method of coupling or displacing a component along a member disclosed herein may be used to couple or displace another movable component along a member.

FIG. **6**B is a schematic view of another embodiment of an agricultural access system **400'** having three vertical support members **410'**. In the illustrated embodiment, vertical support member **411'** and vertical support member **412'** are connected together via an elevated lateral support member **424***a*. A movable coupling component **426***c* may be displacable along elevated lateral support member **424***a*. Movable elevated lateral support member **424***b* is connected to movable coupling component **426***c* and to vertical support member **413'**. Access component **430'** may be displaceable along the length of the movable elevated lateral support member **424***b*. The movable coupling component **426***c* may be displaceable along the length of the elevated lateral support member **424***a* or the elevated lateral support member **424***a* may comprise segments which may be adjusted analogously to the propulsion system disclosed in connection with FIG. **3**. The access component **430'** may be displaceable along the length of the movable elevated lateral support member **424***b* or the elevated lateral support member **424***b* may comprise segments which may be adjusted analogously to the propulsion system disclosed in connection with FIG. **3**. A field **54'**, is also shown in FIG. **6**B.

FIG. **6**C is a schematic view of another embodiment of an agricultural access system **400"** having three vertical support members **410"**. In this embodiment, access component **430"** is coupled to three lateral support members **420"**, each of which is coupled at its other end to a respective one of the vertical support members **410"**. Accordingly, a first end of lateral support member **421"** is coupled to access component **430"**, while a second end of lateral support member **421"** is coupled to vertical support member **411"**. A first end of lateral support member **422"** is coupled to access component **430"**, while a second end of lateral support member **422"** is coupled to vertical support member **412"**. A first end of lateral support member **423"** is coupled to access component **430"**, while a second end of lateral support member **423"** is coupled to vertical support member **413"**. Propulsion systems can be used, analogously to those disclosed in connection with FIG. **3**, to vary the lengths of one or more of the lateral support members **421"**, **422"**, **423"** in order to adjust the position of access component **430"**. A field **54"** is also shown in FIG. **6**C. Variants of this embodiment can be used for systems having 4, 5, or more vertical support members, in order to move access component **430"** within quadrilateral or more general polygonal regions of an agricultural field.

Referring generally to the Figures above, any of the coupling systems, propulsion systems, reels, winches, access components, control systems, and other system components disclosed herein may be used with any embodiment herein. For example, any of the disclosure given in connection with FIG. **6** relative to support members, cables, and movement control may be utilized such that the access component **430** is displaceable within a three dimensional field of motion boarded by the elevated lateral supports **420**, and extending from the tops of the vertical support members **410** to the field **54** or below the field **54** for access components **430** configured to penetrate the ground.

Again, any of the specific features of access components and/or control systems and related functions disclosed herein in connection with any single embodiment may be analogously applied to any other embodiment. Thus the features of the control system and access components of FIGS. **1-5** may be applied to the system of FIG. **6**.

Systems within the scope of this disclosure may comprise a plurality of vertical support members, a plurality of elevated lateral support members (including movable elevated lateral support members), and access components to create a system wherein one or more access members are displaceable within a three dimensional area defined by the system. Any number of members creating various polygons or shapes are within the scope of this disclosure.

FIG. **7** is a schematic view of another embodiment of an agricultural access system **500** having four vertical support members **510**. Specifically, the system **500** comprises a first vertical support member **511**, a second vertical support member **512**, a third vertical support member **513**, and a fourth vertical support member **514**. The system **500** further comprises elevated lateral support members **520**, including a first elevated lateral support member **521**, a second elevated lateral support member **522**, a third elevated lateral support member **523**, a fourth elevated lateral support member **524**, and a movable elevated lateral support member **525**. It is within the scope of this disclosure to configure any of these elevated lateral support members, using any method or structure, such that ends of the movable elevated lateral support members are displaceable along coupled elevated lateral support members and such that the access component **530** is displaceable within a field of motion defined by the system **500**. A field **55** is also shown in this view.

FIG. **8** is a schematic view of another embodiment of an agricultural access system **600** having two movable vertical support members **610**. Specifically, the system **600** comprises a first movable vertical support member **611**, a second movable vertical support member **612**, an elevated lateral support member **620** extending between the movable vertical support members **610**, and an access component **630**. A field **56** is also illustrated. Any of the disclosure relative to any other embodiment, including design and function of control systems, access components, numbers of vertical and/or lateral support

elements, and so forth may be analogously applied to systems comprising movable support members **610**.

In the illustrated embodiment, the movable vertical support members **610** are each coupled to movement systems **615**. These movement systems **615** may comprise track drives, wheels, tracks, rollers, shoes, skids, and so forth. The movement systems **615** may be configured to be moved along a predetermined path, including movement systems configured to be moved along rails. The movement systems **615** may be self-power or configured to be towed by a separate power source.

The movement systems **615** may be configured to position the agricultural access system **600** prior to use, or to move during use such that the field of motion of the access component **630** is moveable as the vertical support members **610** are displaced. Thus, the field of motion of the access component may thus be defined as a three dimensional area bounded by the vertical support members **610**, including areas into which the vertical support members **610** may be moved by the movement systems **615**.

Systems having any number of vertical support members **610** and/or elevated lateral support members **620** may be configured with one or more movement systems **615**. In some embodiments, some vertical support members **610** may be movable while other vertical support members **610** within the same system may be fixed to the ground. Thus, one vertical support member **610** may be configured to translate with respect to another. For example, a system having two vertical support members, one of which is fixed and one movable, may be configured such that the movable vertical support member translates in a generally circular path around the fixed vertical support member.

Systems having more than one movable vertical support member may be configured such that each movable vertical support member is independently movable. Further, a control system configured to control other aspects of the system may also be configured to control the movement of the movable vertical support members. In other embodiments, the control of the movable vertical support members may be independent from a control system configured to control other elements of the system.

FIG. **9** is a top schematic view of another embodiment of an agricultural access system **700** having a plurality of cells **770** and access components **730**. A plurality of vertical support members **710** may be used in connection with any number of elevated lateral support members, including movable lateral support members, to define the cells **770**. Each cell **770** may be associated with an access component **730** displaceable within the associated cell **770**. Any of the coupling systems, propulsion systems, access components and functions, control systems and functions, and so on for the disclosed herein is analogously applicable to embodiments having a plurality of cells.

The various access components **730** may be configured to cooperatively manage a field. In some instances, adjacent access components **730** may be configured to pass tools, items for removal such as weeds or vermin, or other items from one access component **730** to another. A single control system may be configured to operate each of the access components and coordinate passing of materials from one access component to another.

Some systems comprising multiple cells may further define a tool storage cell, **770'**, which may be associated with an access component **730'** configured to access the tool storage area. Such a design may facilitate tool storage within the field of motion of the entire system without placing stored tools within the planted area of the system. The access component **730'** associated with the tool storage area may retrieve a tool which may be passed from various adjacent access components **730** until it is coupled to a desired access component **730**. In this way, a single tool storage area may be utilized by multiple access components **730**, even if each access component does not have a field of motion which reaches the tool storage area.

Some systems comprising multiple cells may comprise one or move movable vertical support members. Access components in the system may interact as the movable vertical support members translate to allow interaction between a first access component and an access component of another cell.

Various methods of accessing an agricultural area are also within the scope of this disclosure. Specifically, methods of accessing an agricultural area using any of the concepts, systems, or components disclosed herein are within the scope of this disclosure.

Without further elaboration, it is believed that one skilled in the art can use the preceding description to utilize the present disclosure to its fullest extent. The examples and embodiments disclosed herein are to be construed as merely illustrative and exemplary and not a limitation of the scope of the present disclosure in any way. It will be apparent to those having skill in the art, having the benefit of this disclosure, that changes may be made to the details of the above-described embodiments without departing from the underlying principles of the disclosure herein.

The invention claimed is:

1. An agricultural access system, comprising:

a first vertical support member, the first vertical support member coupled to a first drive mechanism configured to displace the first vertical support member along the ground;

a second vertical support member;

an elevated lateral support member coupled to the first vertical support member and to the second vertical support member, the elevated lateral support member configured to extend over a portion of an agricultural field, wherein the lateral support member comprises a first segment coupled to the access component and the first vertical support member and a second segment coupled to the access component and the second vertical support member;

an agricultural access component coupled to the lateral support member such that the access component may be positioned at two or more locations between the first vertical support member and the second vertical support member; and

a propulsion system configured to vary at least one of: the length of a portion of the first segment extending between the access component and the first vertical support member and the length of a portion of the second segment extending between the access component and the second vertical support member.

2. The agricultural access system of claim **1**, wherein the first and second vertical support members comprise a first support post and a second support post.

3. The agricultural access system of claim **1**, wherein the second vertical support member is fixed to the ground.

4. The agricultural access system of claim **3**, wherein the first drive mechanism is configured to displace the first vertical support member along a path relative to the position of the second vertical support member.

5. The agricultural access system of claim **4**, wherein the path is a circular path.

6. The agricultural access system of claim 1, wherein the second vertical support member is coupled to a second drive mechanism configured to displace the second vertical support member along the ground.

7. A method of accessing a portion of an agricultural space, the method comprising:

displacing a first agricultural access component coupled to at least one elevated lateral support member which is coupled to a horizontally movable vertical support member so as to access locations between two or more vertical support members,

wherein the lateral support member comprises a first segment coupled to the access component and a first vertical support member and a second segment coupled to the access component and a second vertical support member; and

wherein displacing the access component comprises varying at least one of: the length of a portion of the first segment extending between the access component and the first vertical support member and the length of a portion of the second segment extending between the access component and the second vertical support member.

8. The method of claim 7, further comprising controlling the first access component with a control system, wherein the control system comprises a processor.

9. The method of claim 7, further comprising displacing at least one vertical support member to displace the first access component within a three dimensional cell.

10. The method of claim 8, wherein the control system varies a position of the horizontally movable vertical support member.

11. The method of claim 8, wherein the control system varies a position of the first access component.

12. The agricultural access system of claim 1, wherein the lateral support comprises a cable.

13. The method of claim 7, wherein the lateral support comprises a cable.

14. The method of claim 7, further comprising displacing at least two access components such that the two access components interact.

15. The method of claim 14, further comprising displacing at least one element between at least two adjacent cells through displacement of at least two access components.

16. An agricultural access system, comprising:

a first vertical support member, the first vertical support member coupled to a first drive mechanism configured to displace the first vertical support member along the ground;

a second vertical support member;

an elevated lateral support member coupled to the first vertical support member and to the second vertical support member, the elevated lateral support member configured to extend over a portion of an agricultural field; and

an agricultural access component coupled to the lateral support member such that the access component may be positioned at two or more locations between the first vertical support member and the second vertical support member;

wherein the access component is movable in a substantially horizontal direction along the later support member and

wherein a portion of the access component is movable in a substantially vertical direction, away from the lateral support member, the vertical direction substantially orthogonal to the horizontal direction.

17. The agricultural access system of claim 16, wherein the first and second vertical support members comprise a first support post and a second support post.

18. The agricultural access system of claim 16, wherein the second vertical support member is fixed to the ground.

19. The agricultural access system of claim 18, wherein the first drive mechanism is configured to displace the first vertical support member along a path relative to the position of the second vertical support member.

20. The agricultural access system of claim 19, wherein the path is a circular path.

21. The agricultural access system of claim 16, wherein the second vertical support member is coupled to a second drive mechanism configured to displace the second vertical support member along the ground.

22. A method of accessing a portion of an agricultural space, the method comprising:

displacing a first agricultural access component coupled to at least one elevated lateral support member which is coupled to a horizontally movable vertical support member so as to access locations between two or more vertical support members,

wherein the access component is movable in a substantially horizontal direction along the later support member and

wherein a portion of the access component is movable in a substantially vertical direction, away from the lateral support member, the vertical direction substantially orthogonal to the horizontal direction.

23. The method of claim 22, further comprising controlling the first access component with a control system, wherein the control system comprises a processor.

24. The method of claim 22, further comprising displacing at least one vertical support member to displace the first access component within a three dimensional cell.

25. The method of claim 24, wherein the control system varies a position of the horizontally movable vertical support member.

26. The method of claim 22, wherein the control system varies a position of the first access component.

27. The method of claim 22, further comprising displacing at least two access components such that the two access components interact.

28. The method of claim 27, further comprising displacing at least one element between at least two adjacent cells through displacement of at least two access components.

29. An agricultural access system, comprising:

a plurality of vertical support members, each vertical support member coupled to a drive mechanism of a plurality of drive mechanisms, each drive mechanism configured to displace a vertical support member along the ground, the plurality of vertical support members defining a plurality of cells;

a plurality of elevated lateral support members operably coupled to the plurality of vertical support members; and

a plurality of agricultural access components, each access component operably coupled to at least one lateral support member;

the access system configured such that at least one access component is displaceable within a portion of each cell of the system and

wherein the access components are configured to interact with access components of other cells of the system.

30. The agricultural access system of claim 29, wherein the access components are configured to pass tools to other access components.

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